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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/476,669	12/30/99	LAU G	5298-03500-P

IM52/0312

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EXAMINER	
CANTELMO, G	
ART UNIT	**PAPER NUMBER**
1753	

DATE MAILED: 03/12/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.	Applicant(s)
09/476,669	Lau
Examiner	**Group Art Unit**
Gregg Cantelmo	1753

☒ Responsive to communication(s) filed on *Jan 18, 2001*

☐ This action is **FINAL.**

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire *3* month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claim

☒ Claim(s) *1-20* is/are pending in the applicat

Of the above, claim(s) *19 and 20* is/are withdrawn from consideration

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) *1-18* is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☒ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☒ The drawing(s) filed on *Dec 30, 1999* is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.

☒ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☒ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). *2*

☐ Interview Summary, PTO-413

☒ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of Group I, claims 1-18 in Paper No. 5 is acknowledged.

2. This application contains claims 19-20 drawn to an invention nonelected with traverse in Paper No. 5. A complete reply to a final rejection must include cancellation of nonelected claims or other appropriate action (37 CFR 1.144) See MPEP § 821.01.

Information Disclosure Statement

3. The information disclosure statement filed May 23, 2000 has been placed in the application file and the information referred to therein has been considered as to the merits.

Drawings

4. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because:

a. reference character "310" has been used to designate both the ionizing element (page 17, line 20), the chamber sidewall (page 17, line 22), and the induction coil (page 19, line 13. Correction is required.

b. reference character "406" has been used to designate both the pedestal (page 25, line 19) and the target assembly (page 25, line 6). Correction is required.

c. reference characters "406" and "404" have both been used to designate the target assembly (see page 25, lines 6 and 9). Correction is required.

5. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: In Fig. 2 reference character 320 is not identified. It would seem that this is the induction coil recited on page 17, line 21. Correction is required.

6. Due to the presence of numerous errors in the specification and drawings, applicant is advised to carefully review the specification and drawings to ensure that all reference characters are disclosed and identified in both the specification and drawings.

Claim Rejections - 35 USC § 112

7. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

8. Claims 6-8, 10, and 12-18 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

9. Claim 6 recites the limitation "the dielectric layer" in lines 2 and 3. There is insufficient antecedent basis for this limitation in the claim. Claim 1 does not recite this limitation however a dielectric layer is recited in claim 3.

10. Claim 7 recites the limitation "the microelectronic topography" in lines 3-4. There is insufficient antecedent basis for this limitation in the claim. Neither claims 1 nor 6 recite this feature, however claim 5 does.

11. Claim 8 recites the limitation "the cavity" in line 2. There is insufficient antecedent basis for this limitation in the claim. Neither claims 1 nor 6 recite this feature, however claim 3 does.

12. Claim 10 recites the limitation "the dielectric layer" in line 2. There is insufficient antecedent basis for this limitation in the claim. Claims 1, 6, and 9 do not recite this limitation however a dielectric layer is recited in claim 3.

13. The term "hot sputtering" in claims 12-18 is a relative term which renders the claim indefinite. The term "hot sputtering" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. This instant application renders this term indefinite. On page in page 28 the terms hot and cold sputtering can not clearly be discerned since it states that hot sputtering may actually be cold sputtering and vice versa. Thus the when the claims recite hot sputtering and cold sputtering, the conditions and actual sputtering environment are not clear.

14. The term "conditions" in claims 14 and 15 is a relative term which renders the claims indefinite. The term " conditions " is not defined by the claims, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Neither the claims nor the instant specification appear to disclose or define all of the conditions that that do or do not cause significant reflow of the bulk material. While some process parameters are disclosed in the instant application these conditions to not set forth that

they do or do not cause reflow. In addition, the first paragraph in page 28 renders the terms hot and cold indefinite since it states that hot sputtering may actually be cold sputtering and vice versa. Thus the conditions which do or do not cause reflow are not clear and held to be indefinite.

Claim Rejections - 35 USC § 102

15. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

16. Claims 1, 3-5 and 11 are rejected under 35 U.S.C. 102(e) as being anticipated by U.S. patent No. 6,177,350 (Sundarrajan).

Sundarrajan discloses a method for forming an aluminum metallization. A wetting layer of titanium is deposited over the patterned dielectric surface using ion sputter deposition and an aluminum layer is deposited over the titanium wetting layer using traditional sputter deposition (abstract as applied to claim 1).

Dielectric layer 12 has a cavity formed therein (Fig.1 as applied to claim 3). The wetting layer is titanium (abstract as applied to claim 4). The topography is a microelectronic topography with a lower portion 3 below the dielectric layer 12 and ion sputter depositing the titanium wetting layer on the sidewalls and bottom of the cavity in the dielectric layer 12 (Fig 2, as applied to claim 5).

The bulk layer is aluminum and the wetting layer titanium (abstract as applied to claim 11).

Claim Rejections - 35 USC § 103

17. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

18. Claims 1, 3-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sundarrajan in view of Rossnagel et al. "Magnetron sputter deposition with high levels of metal ionization" (referred to as Rossnagel-93) .

The anticipatory teachings of claims 1, 3-5, and 11 have been discussed above and are incorporated herein. Anticipation being the epitome of obviousness.

RF power is applied to the coil to ionize the titanium atoms sputtered from the target (table 1 as applied to claim 7). The cavity extends to the conductive interconnect 11 (Fig. 1 as applied to claim 8). A sputter-etch cleaning step is employed prior to deposition (col. 6, lines 46-49 as applied to claim 9). This forms facets on the top corners of the cavity of the dielectric layer (col. 7, lines 6-2 as applied to claim 10).

The difference between instant claims 6 and 7 and Sundarrajan are that Sundarrajan does not expressly disclose directing the ions perpendicularly to the substrate (claims 6 and 7) or of applying a bias to the substrate (claim 7).

Ionized metal plasma deposition allows for improved control of the directionality of the metal ions. This allows for a controlled deposition of the sputtered ions into the cavity or contact hole to improve the coverage of the films and prevent void formations.

Rossnagel-93 depicts a sputter deposition chamber wherein the target is in a face to face relationship with the substrate to be coated. A large fraction of the sputtered metal atoms are ionized in the plasma. By placing a negative bias on the sample, metal ions are then accelerated across the sample and deposited at normal incidence (perpendicular incidence).

The motivation for controlling the directionality of the sputtered material to have a normal incidence to the substrate surface is that it would have improved the filling of the contact holes while elimination the formation of voids.

The motivation for applying a negative bias on the sample is that it would have deposited the metal ions at normal incidence and improved the deposition characteristics in the cavities.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Sundarrajan by controlling the directionality of the sputtered material to have a normal incidence to the substrate surface since it would have improved the filling of the contact holes while elimination the formation of voids.

It would have also been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Sundarrajan by applying a

negative bias to the substrate since it would have deposited the metal ions at normal incidence and improved the deposition characteristics in the cavities.

19. Claims 1-5 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sundarrajan in view of U.S. patent No. 6,045,666 (Satitpunwaycha).

The anticipatory teachings of claims 1, 3-5, and 11 have been discussed above and are incorporated herein. Anticipation being the epitome of obviousness.

The difference between instant claim 2 and Sundarrajan is that Sundarrajan does not disclose depositing an insulating layer over the bulk metal layer.

Modern semiconductor integrated circuits usually involve multiple layers separated by dielectric (insulating) layers, such as of silicon dioxide or silica, often referred to simply as an oxide layer, although other materials are being considered for the dielectric. The layers are electrically interconnected by holes penetrating the intervening oxide layer which contact some underlying conductive feature. After the holes are etched, they are filled with a metal, such as aluminum, to electrically connect the bottom layer with the top layer. The generic structure is referred to as a plug. If the underlying layer is silicon or polysilicon, the plug is a contact. If the underlying layer is a metal, the plug is a via (col. 1, lines 20-32).

The motivation for forming an insulating layer atop the metal layer is that it would have been used in the manufacture of IC having multiple layers.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Sundarrajan by forming an

insulation layer atop the metal layer since it would have generated an IC having multiple layers.

20. Claims 1-5, and 11-14 and 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. patent No. 6,156,645 (Geha) in view of either Rossnagel et al "Metal ion deposition from ionized magnetron sputtering discharge" (referred to as Rossnagel-94) or Satitpunwaycha.

Geha discloses sputtering a Ti wetting layer and a subsequent Al bulk metal layer upon the wetting layer into a cavity of a dielectric material (Fig. 3B as applied claims 1 and 3). Insulating layer 503 is deposited above the bulk metal layer 504b (Fig. 5 as applied to claim 2). The wetting layer is Ti and the bulk metal layer is aluminum (as applied to claims 4 and 11). The wetting layer is deposited on the sidewalls of the dielectric material and on the upper surface of the microelectronic topography directly below the cavity (Fig. 3B as applied to claim 5).

Geha discloses a sputtering method wherein the wetting layer and metallization layer are formed in separate chambers (col. 6, lines 65-67). A two step cold and hot deposition process (col. 10, lines 25-30 and col. 11, lines 4-9), deposits the aluminum. The temperature of the cold process is 200 ° C which, absent clear evidence to the contrary, is low enough to deposit the aluminum without causing reflow (as applied to claim 13). The temperature of the hot process is 450 ° C which, absent clear evidence to the contrary, is high enough to cause the second step to cause reflow into the cavity (as applied to claim 14).

The cold aluminum layer is deposited onto the wetting layer as shown in Fig. 3 (claim 16). The hot sputter portion fills the cavity as shown in Fig. 3 (as applied to claim 17). The aluminum layer (bulk metal layer is the first deposition process after the titanium layer is deposited (Fig. 3 as applied to claim 18).

The difference between instant claims 1 and 12 and Geha is that Geha does not disclose IMP depositing titanium in the examples.

However Geha did recognize that IMP depositing of the Ti wetting layer is known in the art (col. 2, lines 41-44). The primary drawbacks of IMP according to Geha are cost and availability of IMP deposition chambers.

Rossnagel-94 teaches that employing a coil to inductively couple the plasma generated the conditions for IMP. Satitpunwaycha also discloses the use of IMP systems to deposit material such as titanium. Thus at the time the claimed invention was made, IMP chambers were known in the art

The motivation for employing IMP deposition is that the directionality of the sputtered atoms of the wetting layer can be controlled. IMP deposition can produce a wetting layer that is even more dense and smooth than that produced by collimation.

The ordinary worker would have found it obvious to employ IMP deposition at the risk of higher costs in order to obtain wetting layers with improved smoothness and density.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Geha by using IMP

deposition to deposit the titanium layer since it would have produced a wetting layer with improved smoothness and density.

21. Claims 6-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Geha in view of Rossnagel-94 or Satitpunwaycha as applied to claims 1-5, 11-14 and 16-18 above, and further in view of Rossnagel-93.

Fig. 5 show the cavity in the dielectric layer extending to a conductive region of the topography (as applied to claim 8).

The differences not yet discussed are directing the ions perpendicularly to the substrate (claims 6 and 7) or of applying a bias to the substrate (claim 7).

Ionized metal plasma deposition allows for improved control of the directionality of the metal ions as recognized by Geha. This allows for a controlled deposition of the sputtered ions into the cavity or contact hole to improve the coverage of the films and prevent void formations. Geha also teaches of IMP deposition as an improvement over collimated sputtering, which is known to direct sputtered material at normal incidence to the substrate surface. Both forms of sputtering control the angle of incidence to improve the fill of the contact holes and eliminate the formation of voids.

Rossnagel-93 depicts a sputter deposition chamber wherein the target is in a face to face relationship with the substrate to be coated. A large fraction of the sputtered metal atoms are ionized in the plasma. By placing a negative bias on the sample, metal ions are then accelerated across the sample and deposited at normal incidence (perpendicular incidence).

The motivation for controlling the directionality of the sputtered material to have a normal incidence to the substrate surface is that it would have improved the filling of the contact holes while elimination the formation of voids.

The motivation for applying a negative bias on the sample is that it would have deposited the metal ions at normal incidence and improved the deposition characteristics in the cavities.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Geha by controlling the directionality of the sputtered material to have a normal incidence to the substrate surface since it would have improved the filling of the contact holes while elimination the formation of voids.

It would have also been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Geha by applying a negative bias to the substrate since it would have deposited the metal ions at normal incidence and improved the deposition characteristics in the cavities.

22. Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Geha in view of Rossnagel-94 or Satitpunwaycha as applied to claims 1-5, 11-14 and 16-18 above, and further in view of U.S. patent No. 5,371,042 (Ong).

The differences not yet discussed are employing a pre-cleaning step (claim 9) forming tapered cavity sidewalls (claim 10).

Geha recognized that typical metallization processes employ a pre-clean step prior to depositing the wetting layer (col. 2, lines 5-8). The pre-cleaning step would

have removed any contaminants from the cavity thereby providing a clean surface for the wetting layer and bulk metal layer to adhere to.

The motivation for providing a pre-cleaning step is that it would have removed contaminants from the cavity thereby providing a clean surface for the wetting layer and bulk metal layer to adhere to (as applied to claim 9).

Ong discloses of faceting the top portion of the openings or vias (abstract).

The motivation for faceting the top portion of the openings or vias is that it would have ensured that openings and vias of submicron size and with high aspect ratios be reliably filled with aluminum having good planarization (paragraph bridging columns 2 and 3 as applied to claim 10).

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Geha by precleaning the substrate prior to depositing the wetting layer since it would have removed contaminants from the cavity thereby providing a clean surface for the wetting layer and bulk metal layer to adhere to

It would have also been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Geha by faceting the top portion of the openings or vias since it would have ensured that openings and vias of submicron size and with high aspect ratios be reliably filled with aluminum having good planarization

23. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Geha in view of either Rossnagel-94 or Satitpunwaycha as applied to claims 1-5, and 11-14 and 16-18 above, and further in view of U.S. patent No. 5,288,665 (Nulman).

The difference not yet discussed is depositing the hot aluminum layer at a lower power level than the cold layer.

Nulman teaches of a multistep aluminum layer deposition. A first step deposits aluminum at 200 ° C (col. 4, lines 13-15). This is the same temperature as the first step in Geha. The second step deposits aluminum between 400 and 600 ° C (col. 4, lines 31-35). The power level during the second application is reduced (col. 4, lines 56-58). This lower desired deposition rate.

The motivation for lowering the target power during the hot sputtering is that it would have provided a lower deposition rate of the aluminum.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Geha by lowering the target power during the hot sputtering step since it would have lowered the deposition rate of the aluminum.

Conclusion

24. In the event that applicant amends the claims, it is respectfully requested that applicant point out where and/or how the originally filed disclosure supports the amendment(s) (i.e., page(s) and line(s); figure(s); etc.). By doing so, the examiner can clearly locate such support and reduce the probability of new matter rejections.

25. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Gregg Cantelmo whose telephone number is (703) 305-0635. The examiner can normally be reached on Monday through Thursday from 8:00 a.m. to 5:30 p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen, can be reached on (703) 308-3322.

FAX communications should be sent to the appropriate FAX number: (703) 305-3599 for After Final Responses only; (703) 305-7718 for all other responses. FAXES received after 4 p.m. will not be processed until the following business day.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

NAM NGUYEN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700

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March 5, 2001